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Beyond Green Infrastructure - Integrating the Ecosystem Services Framework into Urban Planning Law and Policy

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BEYOND GREEN INFRASTRUCTURE—INTEGRATING THE ECOSYSTEM SERVICES FRAMEWORK INTO URBAN PLANNING LAW AND POLICY

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INTRODUCTION

Despite the heavy emphasis in legal scholarship on federal and state governance of environmental policy, cities have had their champions as well. Legal scholars who stand out as having defined a position for local governance in the environmental domain include John Nolan,[1] Jamison Colburn,[2] Keith Hirokawa,[3] Tony Arnold,[4] and, on any such list, Julian Juergensmeyer.[5] Indeed, in the United States and many other nations, cities have been leaders in many of the looming issues of environmental policy, including those with global dimensions, like climate change mitigation, and surely those with local focus, like climate change adaptation.[6]

In the United States, starting with the wave of federal legislation in the 1970s—commonly portrayed as the beginning of modern environmental law and policy and its distinctive "cooperative federalism" model[7]—cities have worked to leverage their traditional role as the locus of land use planning and regulation to

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[1] *See* JOHN R. NOLON, OPEN GROUND: EFFECTIVE LOCAL STRATEGIES FOR PROTECTING NATURAL RESOURCES (2003).

[2] *See* Jamison E. Colburn, *Localism's Ecology: Protecting and Restoring Habitat in the Suburban Nation*, 33 ECOLOGY L.Q. 945 (2006).

[3] *See* Keith Hirokawa, *Environmental Law from the Inside: Local Perspective, Local Potential*, 47 ENVTL. L. REP. NEWS & ANALYSIS 11048 (2017).

[4] Craig Anthony (Tony) Arnold, *Resilient Cities and Adaptive Law*, 50 IDAHO L. REV. 245 (2014); Craig Anthony (Tony) Arnold, *The Structure of the Land Use Regulatory System in the United States*, 22 J. LAND USE AND ENVTL. L. 441 (2007).

[5] *See* James C. Nicholas & Julian Conrad Juergensmeyer, *Market Based Approaches to Environmental Preservation: To Environmental Mitigation Fees and Beyond*, 43 NATURAL RESOURCES J. 837 (2003).

[6] *See* J. Kevin Healy & Margaret Barry, *Local Initiatives*, in GLOBAL CLIMATE CHANGE AND U.S. LAW 375 (Michael B. Gerrard and Jody Freeman, eds. (2014)

[7] *See* RICHARD LAZARUS, THE MAKING OF ENVIRONMENTAL LAW (2004).

insert themselves in the new wave of environmental policy. Expanding land use regulation into a mechanism for advancing an environmental protection agenda, while fraught with political and practical obstacles,[8] became a central goal of many local governments. Broadly speaking, this dispersed but coherent policy initiative to integrate broader environmental goals into local policy has flown under several flags.[9]

For example, many cities began focusing on environmental policy as a mechanism for, and one goal of, what came to be known as "growth management."[10] The related "smart growth" movement evolved from growth management,[11] purporting to offer many win-win outcomes of managing regional growth.[12] Although both growth management and smart growth advocates include environmental values in their array of benefits to be gained,[13] their focus is primarily on solving problems induced by lateral expansion of cities and suburbs—the much reviled "sprawl."[14] Above all is the transportation problem, where applying management techniques such as transit-oriented corridors to solve congestion issues can result in incidental environmental improvement benefits (e.g., reduced impacts to habitat).[15] So-called "green space protection" programs, whether by public purchase of undeveloped land or by requiring contribution of land as private developer mitigation, provide growth management and smart growth regimes a more direct connection to environmental protection.[16] They did

[8] *See* A. Dan Tarlock, *Land Use Regulation: The Weak Link in Environmental Protection*, 82 WASH. L. REV. 651 (2007).

[9] What follows is, of necessity, a brief and simplified review of the "flags" of local initiatives to integrate environmental policy into land use planning and regulation. The phases are not mutually exclusive, nor did one replace another, as in many cities, as well as in law and policy scholarship, the terms used to describe these policy themes may be used in combination. For extensive background, see generally JULIAN CONRAD JUERGENSMEYER & THOMAS E. ROBERTS, LAND USE PLANNING AND DEVELOPMENT REGULATION LAW (3d ed. 2013).

[10] *See* JUERGENSMEYER & ROBERTS, *supra* note 9, at 295-385; Julian C. Juergensmeyer & James C. Nicholas, *Loving Growth Management in the Time of Recession*, 42-43 URBAN LAWYER 413 (2010-11).

[11] *See* Gabor Zovanyi, *The Role of Initial State-Wide Smart-Growth Legislation in Advancing the Tenets of Smart Growth*, 39 URBAN LAWYER 371 (2007).

[12] *See* U.S. Envtl. Prot. Agency, *Smart Growth*, https://www.epa.gov/smartgrowth.

[13] *See id.*

[14] *See* Julian C. Juergensmeyer, *Smart Growth Versus Urban Sprawl in American Growth Management Law*, 3 WARSAW U.L. REV. 39 (2004).

[15] *See* JUERGENSMEYER & ROBERTS, *supra* note 9, at 357-60.

[16] *See id*. at 350-52.

not arise with the ecosystem services framework explicitly in mind, however, and often prioritize provisioning services (e.g., agricultural land preservation) and cultural services (e.g., recreation), although water quality and habitat protection have also been identified as benefits.[17]

Cities eventually became more purposeful in the delivery of direct environmental benefits, particularly through urban design choices, with the rise of the "green infrastructure" movement.[18] The core idea of green infrastructure is to avoid using concrete and other technological "gray infrastructure" materials and substitute with natural materials where possible—e.g., grassy swales and settling ponds instead of a cement drainage system to handle stormwater.[19] Green infrastructure is highly associated with policies aimed at urban sustainability and resilience.[20] Broadly applied, green infrastructure offers many environmental advantages over technological infrastructure alternatives, but it can be costly and may not always be as effective as technological infrastructure in getting the job done. A valid question for green infrastructure, therefore, is what are we getting for the money—what is the return on investment?

Enter the ecosystem services framework. Healthy ecosystems provide human communities a range of economically valuable benefits that are largely taken for granted. Created by the physical and biological processes of ecosystems, ecosystem services underpin society and always have.[21] The benefits ecological resources provide to humans may be usefully divided into four categories: provisioning services (e.g., timber and crops); cultural services (e.g., recreation and spiritual connection); regulating services (e.g., flood control and water purification by

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[17] *See id*. at 350.

[18] *See* Alexandra Dapolito Dunn, *Siting Green Infrastructure: Legal and Policy Solutions to Alleviate Urban Poverty and Promote Healthy Communities*, 37 B.C. ENVTL. AFF. L. REV. 41 (2010).

[19] *See* U.S. Envtl. Prot. Agency, *Green Infrastructure*, https://www.epa.gov/green-infrastructure.

[20] *See* U.S. ENVTL. PROT. AGENCY, ENHANCING SUSTAINABLE COMMUNITIES WITH GREEN INFRASTRUCTURE: A GUIDE TO HELP COMMUNITIES BETTER MANAGE STORMWATER WHILE ACHIEVING OTHER ENVIRONMENTAL, PUBLIC HEALTH, SOCIAL, AND ECONOMIC BENEFITS (2014), *available at* https://www.epa.gov/smartgrowth/enhancing-sustainable-communities-green-infrastructure; Jonathan Rosenbloom, *Fifty Shades of Gray Infrastructure: Land Use and the Failure to Create Resilient Cities*, 93 WASH. L. REV. 317 (2018).

[21] Two landmark publications in 1997 compellingly made this case. *See* NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., 1997); Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253 (1997).

riparian habitat); and supporting services (e.g., nutrient cycling).[22] Think of a large urban park: it can provide space for a community garden to grow herbs and vegetables (provisioning services); it offers space for jogging and meditation (cultural services); it retains and purifies rainwater (regulating services); and it contributes to nutrient cycling in its ponds and wetlands (supporting services). Layered over growth management, smart growth, and, in particular, green infrastructure policies, the ecosystem services framework can facilitate articulation of that return on investment.

The scientific discipline advancing this framework as a way of thinking about the benefits humans derive from ecosystems arose in the mid-1990s, quickly became a central strategy for fusing research by ecologists and economists, and has continued to develop since then.[23] By explicitly describing ecosystems as a form of "natural capital" providing economically valuable benefits to humans, and by advancing a scientifically based argument for integrating those values into private and public decisions, the ecosystem services framework added human well-being to the case for conservation.[24] Prior to this, support for ecosystem conservation had depended largely on appeals to recreational values, environmental well-being, and intrinsic values of nature.[25] This new perspective and its potential to alter the dynamics of public and private resource management decision making, while not free of controversy, rapidly invigorated scientific research and economic thought.[26]

By contrast, the influence of the ecosystem services framework on law and policy has been a more muted, gradual process.[27] One might reasonably have expected otherwise. After all, ecosystem services are, quite literally, essential to

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[22] *See* MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS vi (José Sarukhán et al. eds., 2005), http://www.millenniumassessment.org/documents/document.356.aspx.pdf.

[23] *See* Robert Costanza et al., *Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go?*, 28 ECOSYSTEM SERVICES 1 (2017); Erik Gomez-Baggethun et al., *The History of Ecosystem Services in Economic Theory and Practice: From Early Notions to Markets and Payment Schemes*, 69 ECOLOGICAL ECON. 1209 (2010).

[24] *See* J.B. Ruhl & James Salzman, *The Law and Policy Beginnings of Ecosystem Services*, 22 J. LAND USE & ENVTL. L. 157 (2007).

[25] *See* Costanza et al., *supra* note 23.

[26] *See id.* at 1-2.

[27] *See* Ruhl & Salzman, *supra* note 24. Most of the development of ecosystem services policy has been in connection with programs designed to provide payments for landowners to conserve or enhance natural capital. *See* James Salzman et. al., *Payments for Ecosystem Services: Past, Present and Future*, 6 TEX. A&M L. REV. 199 (2018).

human well-being—try growing crops without renewal of soil fertility or pollination. Given that, ecosystem services should be prized by markets and explicitly addressed in law and policy. Indeed, this has been the case for provisioning ecosystem services such as timber and fish, as well as for cultural services such as recreation. But those have always been overt targets of public resources management and private markets, whether called ecosystem services or not. With few exceptions, however, regulating and supporting services such as water purification and nutrient cycling have been in the background of the legal text of environmental policy.[28] Although environmental law often indirectly advances their conservation—protecting a wetland maintains groundwater recharge—with few exceptions the scientific framework for describing, locating, and valuing regulating and supporting services has not enjoyed explicit adoption in environmental law's legal instruments and decision implementation.

Nevertheless, even against the tide of environmental policy rollback at the federal level and in many states, as well as in other nations, the ecosystem services framework overall has been making some inroads in legal applications,[29] including in local governance. As stressed in the 2011 publication by The Economics of Ecosystems and Biodiversity (TEEB), titled *Manual for Cities: Ecosystem Services for Urban Management*, the importance of cities participating in this global initiative cannot be overstated—urban areas are home to over half the world's population, making cities the chief consumer of ecosystem services.[30] Yet, just a few years later, in their assessment of research needs on urban ecosystem services, Salzman et al. concluded that "little is understood about the ways and methods that ecosystem service values might be incorporated into local decision-making."[31] Fortunately, research on urban ecosystem services has boomed since then and has begun to close that gap.

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[28] *See* Justine Bell-James, *Integrating the Ecosystem Services Paradigm into Environmental Law: A Mechanism to Protect Mangrove Ecosystems?*, 31 J. ENVTL. L. 291 (2019); Amy M. Villamagna et al., *Capacity, Pressure, Demand, and Flow: A Conceptual Framework for Analyzing Ecosystem Service Production and Delivery*, 15 ECOLOGICAL COMPLEXITY 114 (2013).

[29] For examples of continued progress at national governance scales, see Lars Hein et al., *Progress in Natural Capital Accounting for Ecosystems*, 367 SCIENCE 514 (2020).

[30] *See* TEEB – THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY, TEEB MANUAL FOR CITIES: ECOSYSTEM SERVICES IN URBAN MANAGEMENT 2 (2011), available at http://doc.teebweb.org/wp-content/uploads/Study%20and%20Reports/Additional%20Reports/Manual%20for%20Cities/TEEB%20Manual%20for%20Cities_English.pdf.

[31] James Salzman et al., *The Most Important Current Research Questions in Urban Ecosystem Services*, 25 DUKE ENVTL. L. & POL'Y F. 1, 45 (2014).

This Essay, intended to recognize Julian Juergensmeyer's immense body of scholarship on local land use law by anticipating where he would go with ecosystem services, traces that trend and charts policies and practices cities could adopt to facilitate further development and solidification of the ecosystem services framework as a policy instrument for local environmental governance. Part I offers a brief orientation to the challenges of integrating the ecosystem services framework into land use and environmental governance. Part II points to the fast-growing body of research on how cities in the United States and other nations have (or have not) adopted the ecosystem services framework in their planning processes. Part III then synthesizes that body of work to outline general principles and guidelines for local policy. The hope is that, much as early pioneers such as Professor Juergensmeyer helped to steer cities toward environmental policy with mitigation fees and similar land use regulation mechanisms, this effort can promote integration of the ecosystem services framework into city planning.[32]

I. Policy Integration Challenges

Although by the late 1990s the ecosystem services framework had become mainstream in ecology, economics, and other disciplines related to environmental and natural resources management, transferring the idea into legal frameworks has proven challenging. High-level policy discourse did begin to pick up the theme, to be sure. In 1998, for example, the President's Council of Advisors on Science and Technology (PCAST) issued a report emphasizing the importance of the nation's "living capital," the term it used to define the natural resources providing ecosystem services.[33] The United Nations embraced the concept as well, relying on measures of ecosystem services throughout the world in an influential 2005 report that

[32] By no means am I the first to advance this theme. For thoughtful prior contributions by leading thinkers, see Keith Hirokawa, *Sustainability and the Urban Forest: An Ecosystem Services Perspective*, 51 NATURAL RESOURCES J. 233 (2012); Keith Hirokawa, *Sustaining Ecosystem Services through Local Environmental Law*, 28 PACE ENVTL. L. REV. 760 (2011); Salzman et al., *supra* note 31. My addition to the effort, I am hopeful, is to integrate more recent innovative scientific and policy research studying how cities from different nations use (or do not use) the ecosystem services framework.

[33] *See* BIODIVERSITY AND ECOSYSTEMS PANEL, PCAST, TEAMING WITH LIFE: INVESTING IN SCIENCE TO UNDERSTAND AND USE AMERICA'S LIVING CAPITAL (1998), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-teamingwithlife.pdf.

explicitly tied ecosystem services to human prosperity.[34] But uptake in actual law on the books was slow to come.

There are three reasons that regulating and supporting ecosystem services in particular have been largely ignored in law and policy. The first is that they are, for all practical purposes, free. Markets explicitly value and assign dollar figures to certain "ecosystem goods," such as timber and seafood. These fall into the provisioning services category. Yet, almost without exception, the regulating and supporting services underpinning the production of these goods have no market value—not because they are worthless but, rather, because there is no market to capture and express their value directly.[35] For example, the owner of a large wetland area—the "natural capital" producing the ecosystem service of groundwater recharge—cannot prevent nearby or distant properties from withdrawing the groundwater the wetlands supply. So why would the beneficiaries pay for those services? And even if one property owner did pay, the others would still benefit. Under such conditions, markets for the service will not arise.[36]

The second reason is that we do not fully understand the biophysical provision of services, particularly of regulating and supporting services.[37] If we convert the wetland in the prior example to a shopping mall, its groundwater recharge service vanishes. But most land use decisions are marginal—only a small section of a wetlands will be paved here, and another there. Scientists do not have a granular-scale understanding what will happen to groundwater recharge and other services if 5 or 10 percent of each wetland is developed.

And finally, there are serious institutional obstacles to incorporating regulating and supporting services into law and policy.[38] A map of counties and states shows a lot of boundary lines, but such political jurisdictions rarely track the contours of ecosystems, much less the flow of ecosystem services between jurisdictions. In general, the area where ecosystem services originate—the natural capital resources such as the wetlands in the example above—does not align with the political reach of those who benefit. And because the scales of providers and beneficiaries do not match, there are significant collective action problems.

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[34] *See* MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: SYNTHESIS (Jose Sarukhan et al. eds., 2005).

[35] *See* Christopher L. Lant et al., *The Tragedy of Ecosystem Services*, 58 BIOSCIENCE 969, 970–71 (2008).

[36] *See id.*

[37] *See* Salzman et al., *supra* note 31, at 5-6.

[38] *See id.*

Cities have long faced all three of these problems when attempting to influence conservation of large-scale resources such as habitat biodiversity or watershed management.[39] Managing the flow of ecosystem services into and from a city is particularly challenging in this respect. For example, landowners in a suburban watershed may provide ecosystem services of flood prevention and water quality to the city in the lower watershed, but the downstream urban beneficiaries may have no political means to influence land management in the suburban upper watershed, which might even be in a different county or state. And the reverse can be true—the city's investment in improving water quality in a river running through the downtown area necessarily benefits downstream jurisdictions over which the city has no control. In either case, cities also have fewer options for management of natural capital located within their political boundaries, as undeveloped tracts may be scarce and subject to development pressures, and parks and other conserved areas often serve primarily as recreational resources (cultural services).[40]

Despite these challenges, over the past decade policy makers at all governance scales have received and responded to the ecosystem services message, and progress is being made.[41] The focus in this review is on how that trend has progressed in local government land use planning and regulation.

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[39] *See* A. Dan Tarlock, *Local Government Protection of Biodiversity: What is its Niche?*, 46 LAND USE LAW & ZONING DIGEST 4 (1994). A. Dan Tarlock, *The Potential Role of Local Governments in Watershed Management*, 20 PACE ENVIRONMENTAL LAW REVIEW 149 (2002).

[40] *See* J.B. Ruhl, *Adaptive Management of Ecosystem Services across Different Land Use Regimes*, 183 J. ENVTL. MGMT. 418 (2016).

[41] *See*, *e.g.*, Memorandum on Incorporating Services into Federal Decision Making from Shaun Donovan, Dir., Office of Mgmt. and Budget, Christina Goldfuss, Managing Dir., Council on Envtl. Quality, and John Holdren, Dir., Office of Sci. and Tech. Policy (Oct. 7, 2015), https://obamawhitehouse.archives.gov/sites/default/ files/omb/memoranda/2016/m-16-01.pdf (directing federal agencies directed "to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts").

II. Comparative Research on City Planning and Ecosystem Services

There has been a worldwide explosion of interest in urban planning and ecosystem services in scientific and policy research over the past five years,[42] with a strong focus on urban green infrastructure as a source of regulating and supporting services.[43] In particular, comparative studies have aimed at extracting both cross-cutting and distinctive themes.[44] For example, in their 2015 study, Fransesc Baro et al. develop a method for evaluating the supply of and demand for ecosystems services associated with green infrastructure at local urban scales, applying it to detect supply and demand mismatches in five representative European cities.[45]

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[42] *See* Fransesc Baro et al., *Mapping Ecosystem Service Capacity, Flow and Demand for Landscape and Urban Planning: A Case Study in the Barcelona Metropolitan Region*, 57 LAND USE POLICY 405 (2016); Wanxu Chen et al., *The Spatial Aspect of Ecosystem Services Balance and Its Determinants*, 90 LAND USE POLICY 104263 (2020); Fengqi Cui et al., *Integrating Ecosystem Services Supply and Demand into Optimized Management at Different Scales: A Case Study in Hulunbuir, China*, 39 ECOSYSTEM SERVICES 100984 (2019); Chiara Cortinovos & Davide Geneletti, *A Framework to Explore the Effects of Urban Planning Decisions on Regulating Ecosystem Services in Cities*, 38 ECOSYSTEM SERVICES 100946 (2019); Peer von Dohren & Dagmar Haase, *Risk Assessment Concerning Urban Ecosystem Disservices: The Example of Street Trees in Berlin, Germany*, 40 ECOSYSTEM SERVICES 101031 (2019); Junyi Hua & Wendy Y. Chen, *Prioritizing Urban Rivers' Ecosystem Services: An Importance-Performance Analysis*, 94 CITIES 11 (2019); Jeannette Sieber & Manon Pons, *Assessment of Urban Ecosystem Services Using Ecosystem Services Reviews and GIS-Based Tools*, 115 PROCEDIA ENGINEERING 53 (115) (2015). For a survey of science and legal scholarship on urban ecosystem services prior to this wave, see Salzman et al., *supra* note __, at 7-15.

[43] *See* Judy Bush & Andreanne Doyon, *Building Urban Resilience with Nature-Based Solutions: How Can Urban Planning Contribute?*, 95 CITIES 102483 (2019); Luyuan Li et al., *Planning Green Infrastructure to Mitigate Urban Surface Water Flooding Risk – A Methodology to Identify Priority Areas in the City of Ghent*, 194 LANDSCAPE AND URBAN PLANNING 103703 (2020); Richard A.S. Machado et al., *Urban Ecological Infrastructure: The Importance of Vegetation Cover in the Control of Floods and Landslides in Salvador/Bahia, Brazil*, 89 LAND USE POLICY 104180 (2019); Sylvia Ronchi et al., *Integrating Urban Infrastructure into Spatial Planning Regulations to Improve the Performance of Urban Ecosystems: Insights from an Italian Case Study*, 53 SUSTAINABLE CITIES 101907 (2020); Sining Zhang & Fransesc Munoz Ramirez, *Assessing and Mapping Ecosystem Services to Support Urban Green Infrastructure: The Case of Barcelona, Spain*, 92 CITIES 59 (2019).

[44] *See* Francesc Baro et al., *Mismatches Between Ecosystem Services Supply and Demand in Urban Areas: A Quantitative Assessment in Five European Cities*, 55 ECOLOGICAL INDICATORS 146 (2015); Rieke Hansen et al., *The Uptake of the Ecosystem Services Concept in Planning Discourses of Eurpoean and American Cities*, 12 ECOSYSTEM SERVICES 228 (2012); B. Pandeya et al., *A Comparative Analysis of Ecosystem Services Valuation Approaches for Application at the Local Scale and in Data Scarce Regions*, 22 ECOSYSTEM SERVICES 250 (2016)

[45] *See* Baro et al., *supra* note 44. The cities were Barcelona, Berlin, Stockholm, Rotterdam, and Salzburg.

They use three regulating ecosystem services—air purification, urban temperature regulation, and carbon sequestration. Demand for these services was derived by using existing environmental quality standards, such as ambient air concentrations for specified pollutants, as proxies, and then comparing the standard to the actual levels in each city.[46] This avoided the problem of lack of market or other demand indicators. Importantly, demand was derived for local scales, even when the service has global benefits. For example, they estimated local demand for carbon sequestration, which benefits global greenhouse gas levels, by referring to the greenhouse gas reduction goals to which the cities had committed and comparing that to the existing emission levels.[47] Supply was estimated by using known properties of the green infrastructure, such as pollutant uptake, shade effect of canopy cover, and carbon storage rates of vegetation, and determining total effects of the green infrastructure present in each city.[48] They found that this methodology could be applied across the various cities with consistency, and thus could be useful for any city.

Overall, Baro et al. concluded that core urban green infrastructure played only a minor or complementary role in reducing air pollutants, coping with heat waves, and providing direct carbon sequestration, attributing this to the lack of available land and the increasing densification of urban spaces.[49] In short, the built environment of urbanizing areas can run low on areas to expand the natural capital needed to fuel regulating and supporting services. On the other hand, as they point out, green infrastructure often is providing all three of these benefits and others, such as stormwater control, whereas technological infrastructure (e.g., a concrete stormwater collector) is often single-purpose. Green infrastructure thus might provide less effective stormwater control than its technological counterpart, but is also supplying other benefits the concrete cannot. This is just the kind of trade-off research like on urban ecosystem services can help inform as a matter of urban policy choice. Similar demand and supply studies have since been conducted for a growing number of cities.[50]

Importantly, however, city governments do not always explicitly adopt the ecosystem services framework in their planning document terminology when pursuing policies that effectively conserve ecosystem services. For example, Rieke

[46] *See id.* at 147-48.

[47] *See id.* at 147.

[48] *See id.* at 148.

[49] *See id.* at 155.

[50] *See supra* notes 42 and 43.

Hansen et al. studied urban planning policies of five cites in Europe and the United States for over 20 ecosystem services, including several in the regulating and supporting categories.[51] They found only two cities—New York City and Stockholm—included frequent explicit references to the ecosystem services framework in planning documents, although some references in the other cities' documents were to similar concepts, such as "ecosystem benefits." [52] All five cities also included implicit references to what would be called "natural capital" (e.g., a reference to habitat or watersheds) and "ecosystem services" (e.g., a reference to clean air) under that framework.[53] The emphasis in all cases was mostly on habitat protection, which is a source of regulating and supporting services, and on recreation and other cultural services.[54] Hansen et al. found that the most important driver of uptake of the terminology in planning documents was the presence of high-level policy documents, such as New York City's PlaNYC, holistically promoting the ecosystem services framework across an array of city policy domains.[55]

Of course, lack of explicit references to the ecosystem services terminology in planning documents does not necessarily suggest lack of ecosystem services conservation—promoting groundwater recharge does not require that a planning department call it a regulating service—and explicit references could be merely lip service. Nevertheless, where a city is genuinely interested in promoting green infrastructure's benefits, explicit adoption of the ecosystem services framework terminology can help advance urban planning policy in two key respects. First, it makes more clear for citizens the connection between urban natural resources and human well-being—it drives home the ROI of green infrastructure.[56] Second, as more cities adopt the framework, planners can share strategies and research across cities using a common language, as well as connect more directly with academic

[51] *See* Hansen et al., *supra* note 43. The cities were Berlin, New York City, Salzburg, Seattle, and Stockholm.

[52] *See id.* at 233-40.

[53] *See id.*

[54] *See id.*

[55] *See id.* at 237. For examples of this kind of high-level, holistic embrace of the ecosystem services framework in urban planning contexts, see Hirokawa, *Sustaining Ecosystem Services*, *supra* note 32, at 787-94.

[56] *See id.*

researchers and state and national governments already widely using the terminology.[57]

III. Implementing the Ecosystem Services Framework

Beyond explicit adoption of the ecosystem services terminology, how could a city wishing to integrate an ecosystem services focus in its planning culture and policy best go about doing so? The 2011 TEEB *Manual for Cities* lays out six key steps in this respect:[58]

> Step 1: Specify and agree on the problem or policy issue with stakeholders
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> Step 2: Identify which ecosystem services are most relevant
>
> Step 3: Determine what information is needed and select assessment methods
>
> Step 4: Assess (future changes in) ecosystem services
>
> Step 5: Identify and assess management/policy options
>
> Step 6: Assess the impact of the policy options on the range of stakeholders

Stakeholder consultation and participation (Steps 1 and 6) is an obvious ingredient for launching new policy initiatives. The real challenge for integrating the ecosystem services framework into urban planning are the steps that go to the heart of the question: what natural capital do we have, who is it benefitting, and should we promote more? The growing body of research referenced herein focuses on several of these steps in particular.

First, many of the researchers emphasize the need for what Seiber and Pons call an "ecosystem services review" (ESR)—a robust inventory of supply and demand that can be represented through mapping, which today means through geographic information software (GIS).[59] Critically, the ESR cannot be limited to the provisioning and cultural services cities have long been comfortable

[57] See i*d*.; Ronchi et al., *supra* note 43, at 10.

[58] *See* TEEB, *supra* note 30, at 11; *see also* Salzman et al., *supra* note 31, at 45-46 (laying out similar research needs).

[59] *See* Siber & Pons, *supra* note 42; *see also* Baro et al, *supra* note 42; Chen et al, *supra* note 42; Cui et al., *supra* note 42; Villamagna et al., *supra* note 42; Zhang & Ramirez, *supra* note 43. For examples of cities engaging in this type of ecosystem services assessment, see Hirokawa, *Sustaining Ecosystem Services*, *supra* note 32, at 787-94.

managing—it must include regulating and supporting services. The ESR must be both spatially explicit—where is the natural capital, where are its beneficiaries, and how does the service flow from point A to point B? It must also take into account the "disservices," or negative effects, of green infrastructure, such as allergens from trees.[60]

Second, although the ESR should include as broad a set of ecosystem services as feasible, ultimately urban policy makers must prioritize. This requires an understanding not only of the risks and vulnerabilities urban policy has prioritized—flooding being one that recurs in the research[61]—but also of the trade-offs between ecosystems services and between green infrastructure (as natural capital) and technological infrastructure.[62] The TEEB *Manual for Cities* emphasizes that prioritization is also driven by an assessment of which ecosystem services are most at risk of depletion and the impact that could have on stakeholders.[63] Hua and Chen, in their study of urban river ecosystem services in China, call this the "importance-performance analysis," [64] a technique used in customer satisfaction studies but which has not been applied in the ecosystem services context to gauge citizens' ecosystem service preferences and their satisfaction with green infrastructure's performance in delivering them. Interestingly, they found people place high importance on regulating services such as purification, flood control, water supply, and cooling, but also found high gaps between preferences and performance satisfaction in each case.[65] This kind of finding can help local planners prioritize green infrastructure.

Third, prioritized services can then undergo a more tailor-made ESR in the form of spatially explicit mapping of supply sources and beneficiary populations, the objective being to assess current natural capital stocks and qualitatively describe, and quantitatively assess where possible, the value of the benefits. Policy makers can then assess the return on investment of existing and additional green infrastructure and compare that to technological infrastructure. Where it makes sense to use green infrastructure, urban planners can develop appropriate strategies

[60] *See* von Dohren & Haase, *supra* note 42.

[61] *See* Li et al, *supra* note 43; Machado et al., *supra* note 43.

[62] *See* Bush & Doyon, *supra* note 43.

[63] *See* TEEB, *supra* note 30, at 15.

[64] Hua & Chen, *supra* note 42, at 11.

[65] *Id*. at 16.

including zoning restrictions, development standards, public investment, impact fees, and other tools familiar to local land use regulation.

To be sure, cities cannot put this kind of research program together overnight, and funding and other challenges will also be present. But the volume of scientific research aimed at urban planning and ecosystem services over the past five years is impressive, and it keeps growing. Adopting the ecosystem services framework as the language of green infrastructure can be an important catalyst for translating that research into practice and building a body of research and experience that can be shared between cities worldwide.

CONCLUSION

Legal scholars of land use policy, of whom Julian Juergensmeyer is an undisputed leader, have played an instrumental role in promoting the theory and practice of broad policy movements such as growth management, smart growth, and green infrastructure. As cities take on larger roles in environmental policy, this body of work has proven instrumental. This Essay has asked, what next? Where can urban planning look to further advance these policy themes, green infrastructure in particular? The ecosystem services framework, which has become nothing less than ubiquitous in current scientific research on ecosystem management, is ripe for the picking. Given his keen eye over his career for identifying, articulating, and building the next wave of urban planning policy and practice, I am hopeful that Professor Juergensmeyer would agree.